



Stanford University
Global Climate & Energy Project

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Introduction to GCEP and Purpose of Workshop

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***GCEP International Workshop: Exploring the Opportunities to Integrate Advanced
Coal Technologies with Carbon Capture and Storage in China***

Beijing, China



Outline



- Global Challenge
- GCEP Response
- Research Opportunities in China
- Workshop Goals and Plans



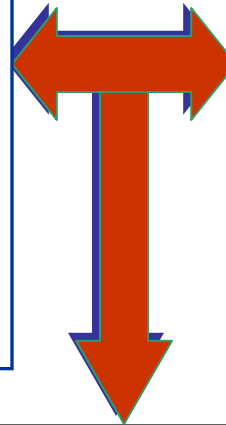
The Grand Challenge



Needs

- Growth in world population to 9 billion from 6 billion, of which 2 billion people currently have no access to modern energy systems
- Improved standard of living in growing economies of developing world
- Increased demands for energy, food, land, and materials.

Protection,
Restoration, and
Improvement of the
Planetary
Biogeochemical
Systems

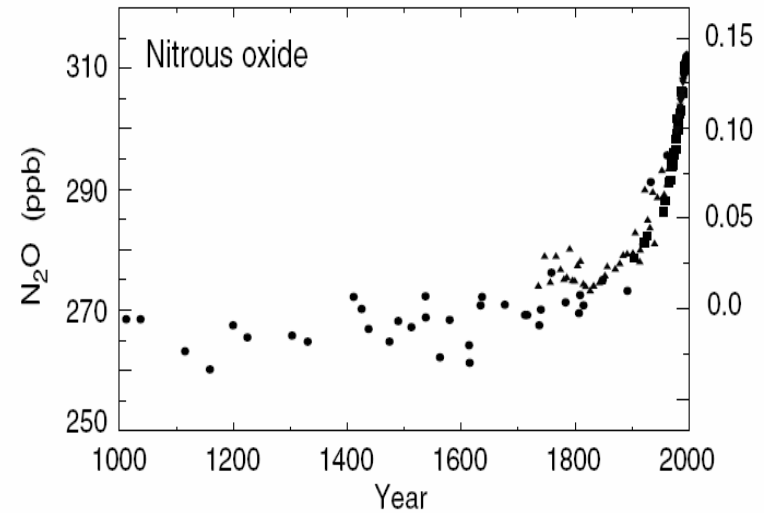
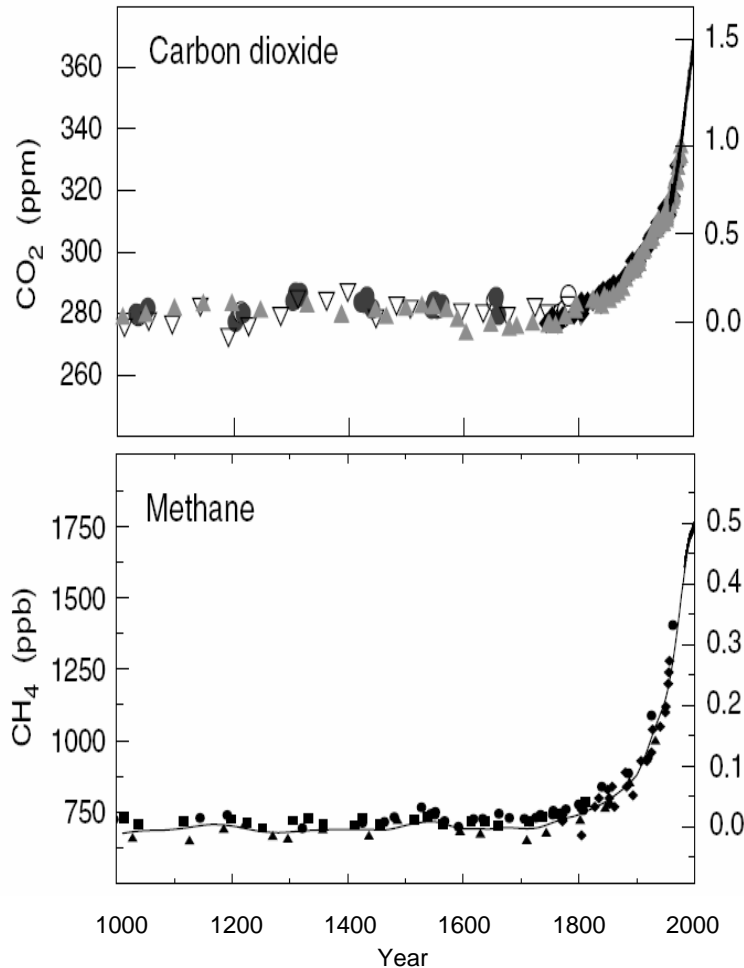


Component Challenges

- Water supply
- Agricultural systems (strongly linked to water supply)
- **Energy (with possible limits on CO₂ emission)**



Global Geochemical History



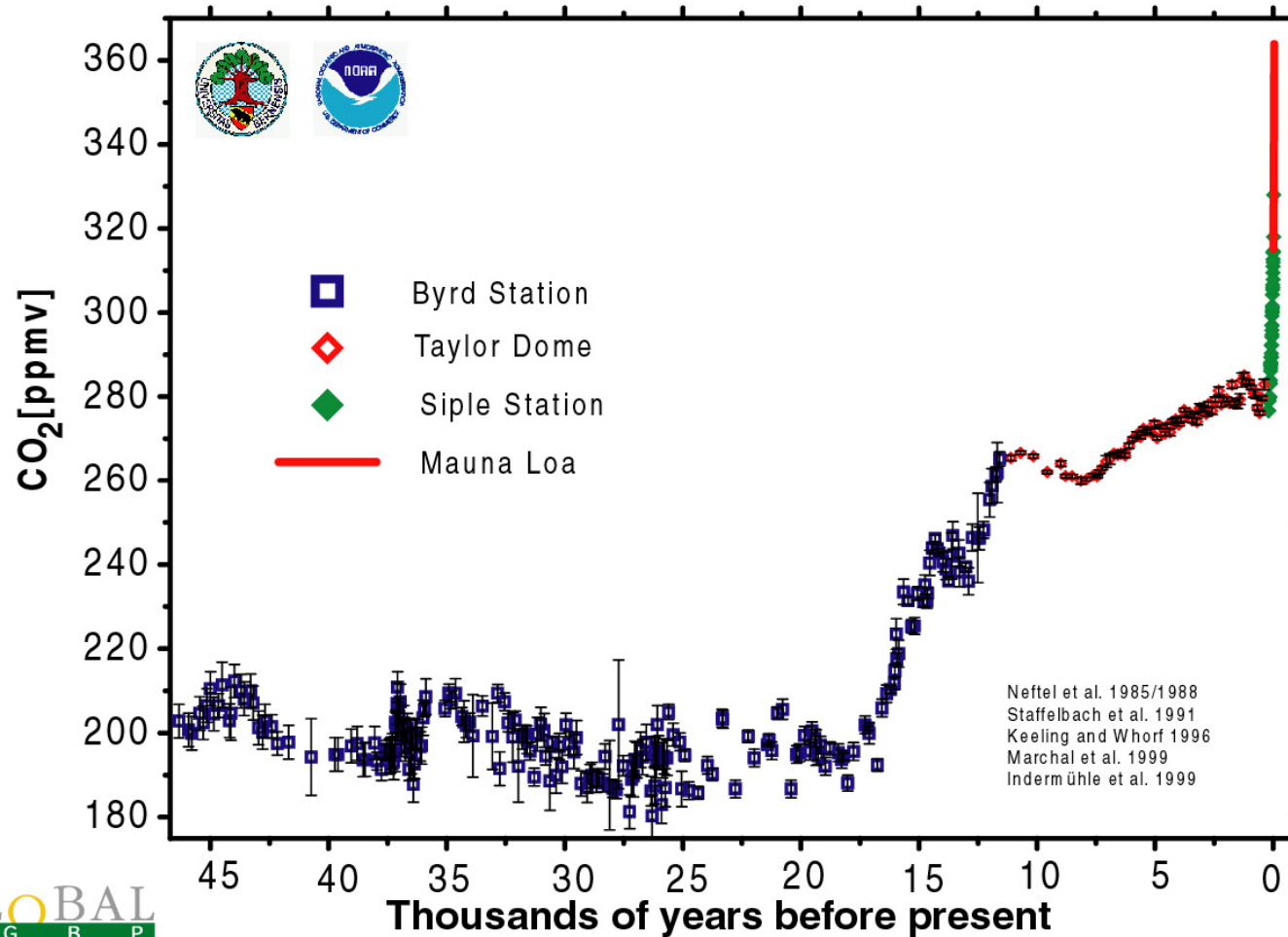
- Concentrations of GHGs have risen significantly over the preindustrial levels.

Source: IPCC Third Assessment Report, 2001



Atmospheric CO₂ Concentration

- Last Glacial Maximum to Present

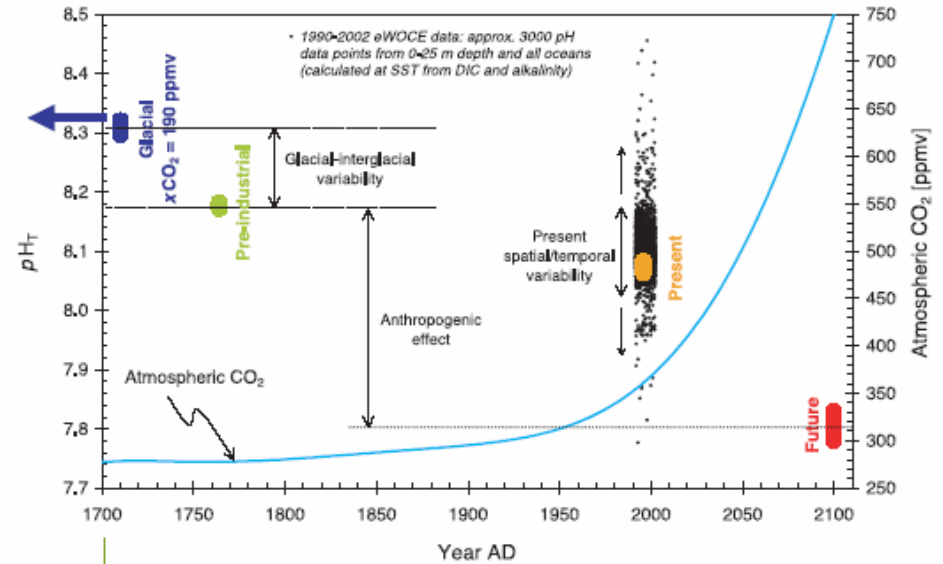
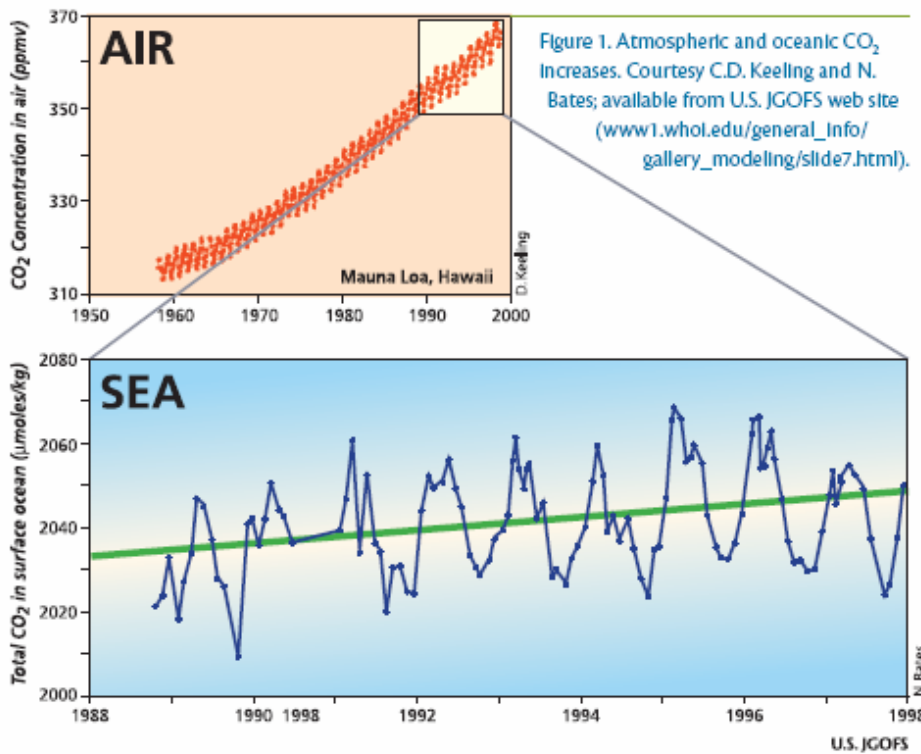


Adapted from: http://www.climate.unibe.ch/gallery_co2.html





The Oceans in a High CO₂ World

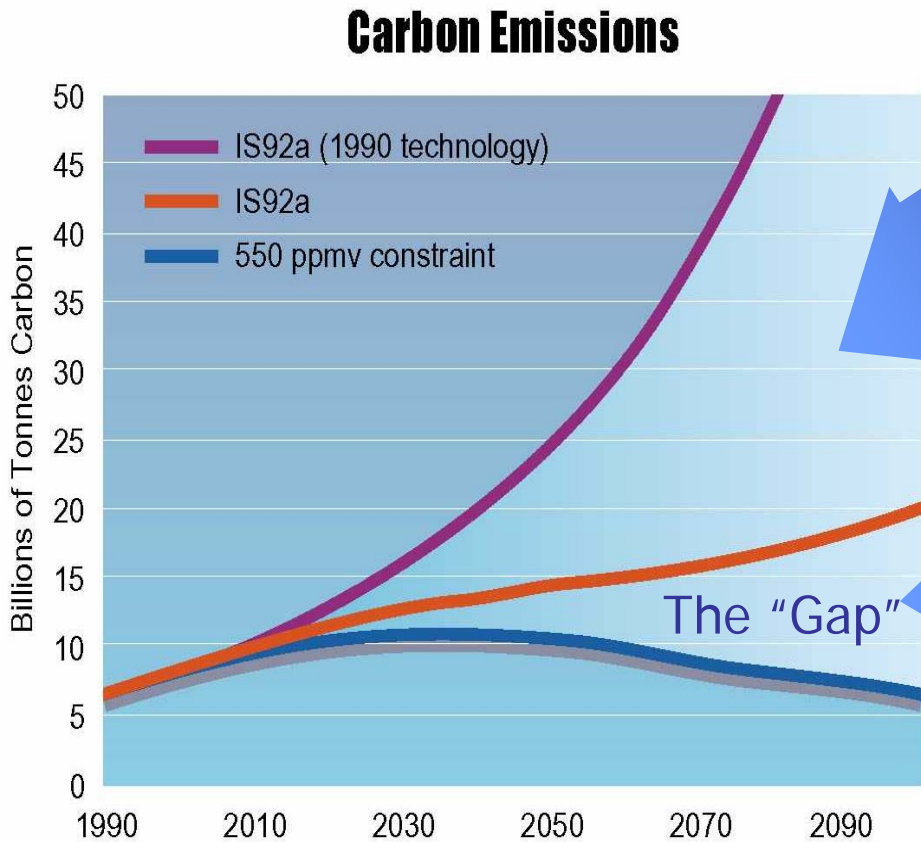


The oceans have taken up ~400 Gt of fossil fuel CO₂. Global surface oceans now remove 20-25 Mt CO₂/day.

Decline in pH (0.1 since industrial revolution) affects bicarbonate, carbonate ion concentrations, rates of fixation of CaCO₃ by assorted critters in the trophic chain, potential for feedbacks with temperature change. Source: Oceanography Vol.17, No.3, Sept. 2004



The Need for Technology



Assumed Advances In:

- Fossil Fuels
- Energy intensity
- Nuclear
- Renewables

Gap Technologies:

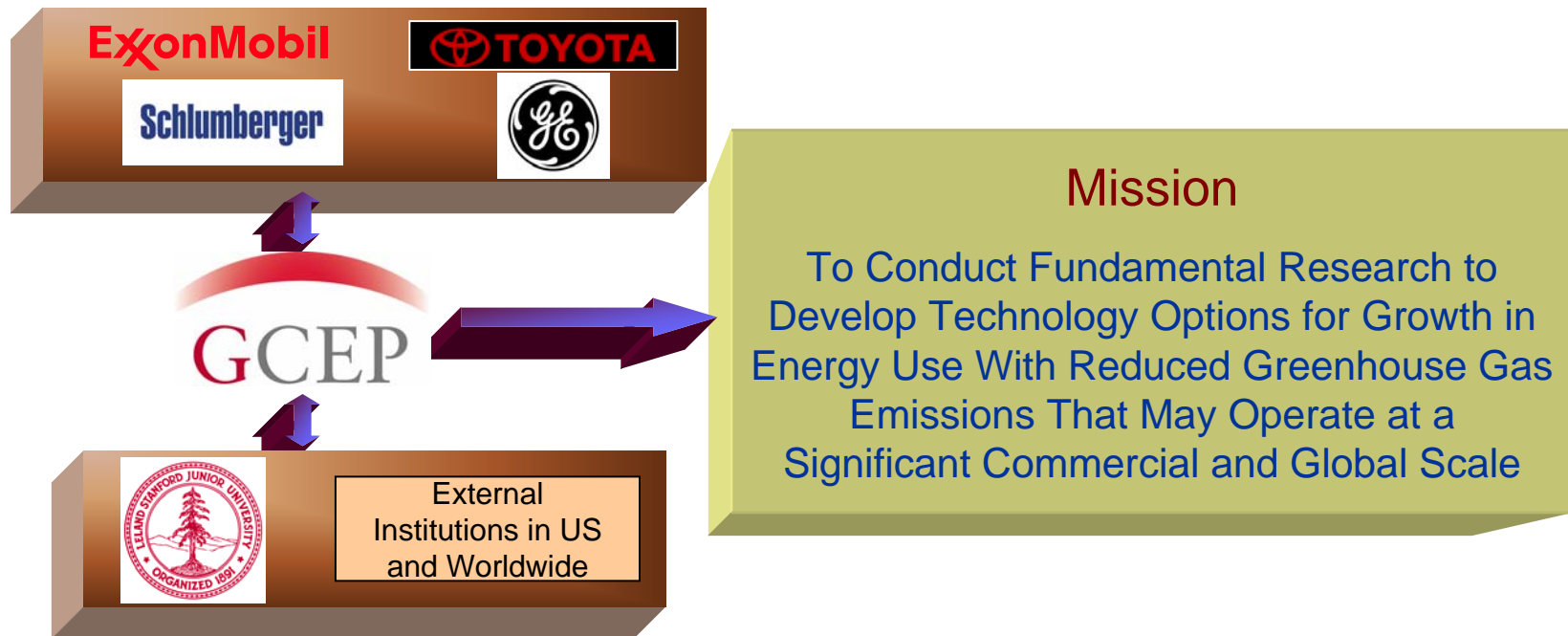
- Carbon capture & disposal
 - Adv. fossil
- H₂ and Adv. Transportation
- Biotechnologies
 - Soils, Bioenergy, Adv. Biological Energy



The GCEP R&D Program to Generate Technology Options



- The Global Climate and Energy Project (GCEP) was established to conduct pre-commercial research necessary to develop the technology options needed to address a low greenhouse gas future.
- GCEP is an unprecedented research alliance between a university and leading global corporations
- It represents a 10-year, \$225M commitment to developing groundbreaking technologies that may have a significant impact on a global scale





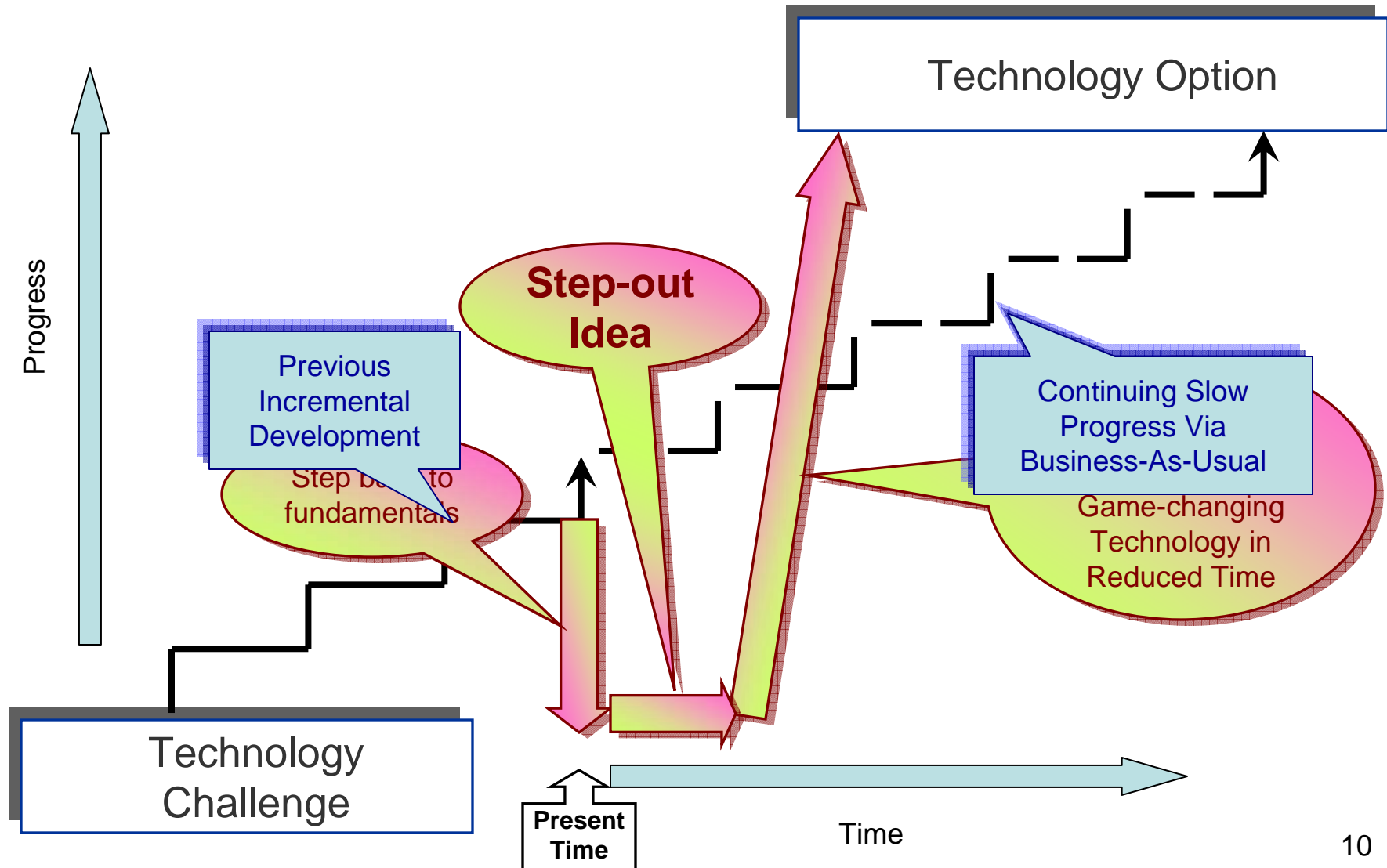
GCEP Strategy



- Focus on potential energy technologies that may be truly game-changing with respect to greenhouse gas emissions
- Encourage high risk/high reward research
- Apply within a portfolio of technical areas
- Address questions appropriate to pre-commercial research that may have an impact in the 10-50 year timeframe
- Use the best research talent available
- Make all data, results, and other information generated from the project open and available to all
- Involve institutions from countries with potential high levels of future greenhouse gas emissions

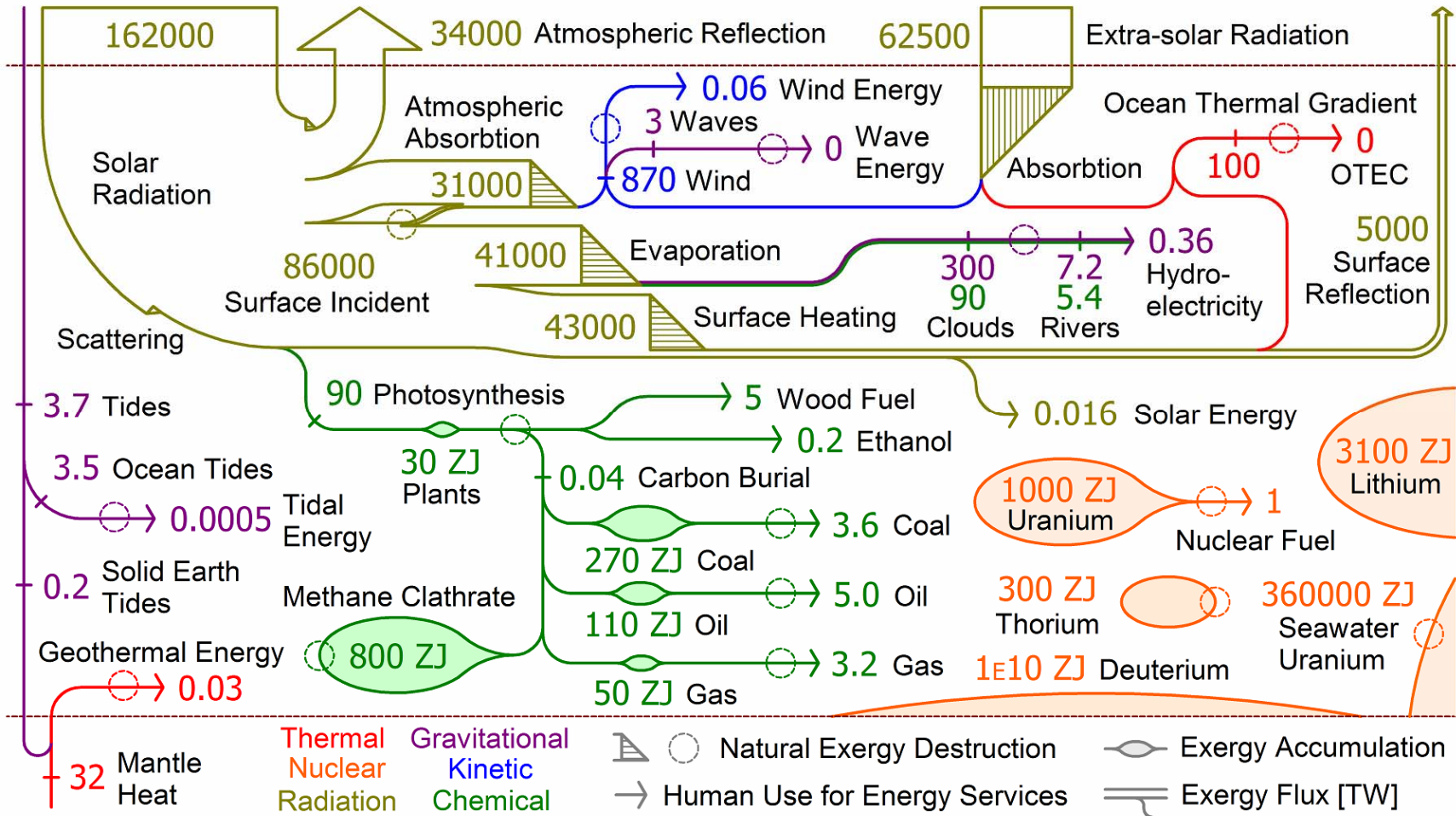


Step-Out Technology





Exergy Flow of Planet Earth (TW)



Current Global Exergy Usage Rate ~ 15 TW (0.5 ZJ per year)

$$86000/15 = 5733$$

Source: W. Hermann, GCEP Systems Analysis Group 2004.

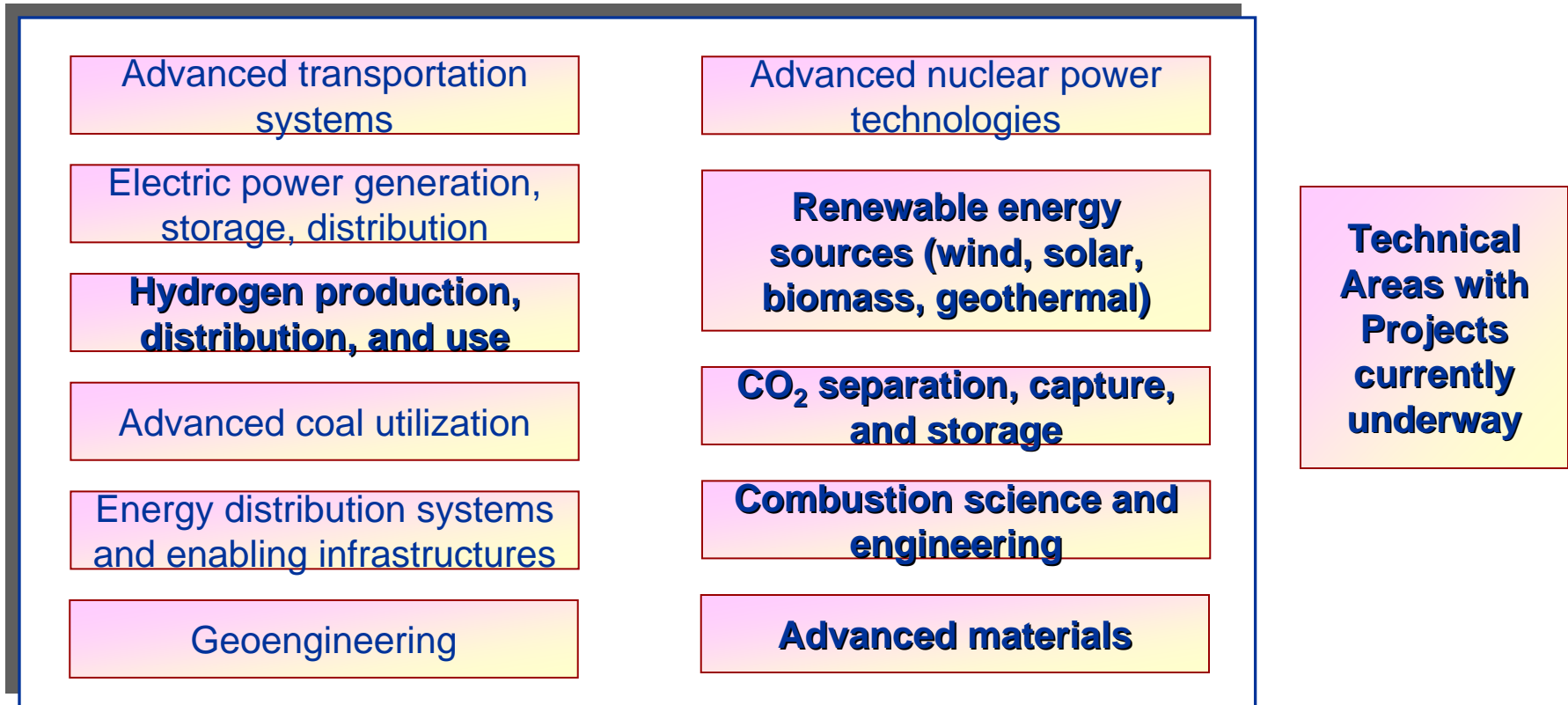
$$(1 \text{ ZJ} = 10^{21} \text{ J})$$



Portfolio Areas



- GCEP portfolio currently includes 11 technical areas:



- Portfolio development and maintenance is supported by thorough assessment and analysis efforts



China, USA, and the World in 2002

(with world rankings)

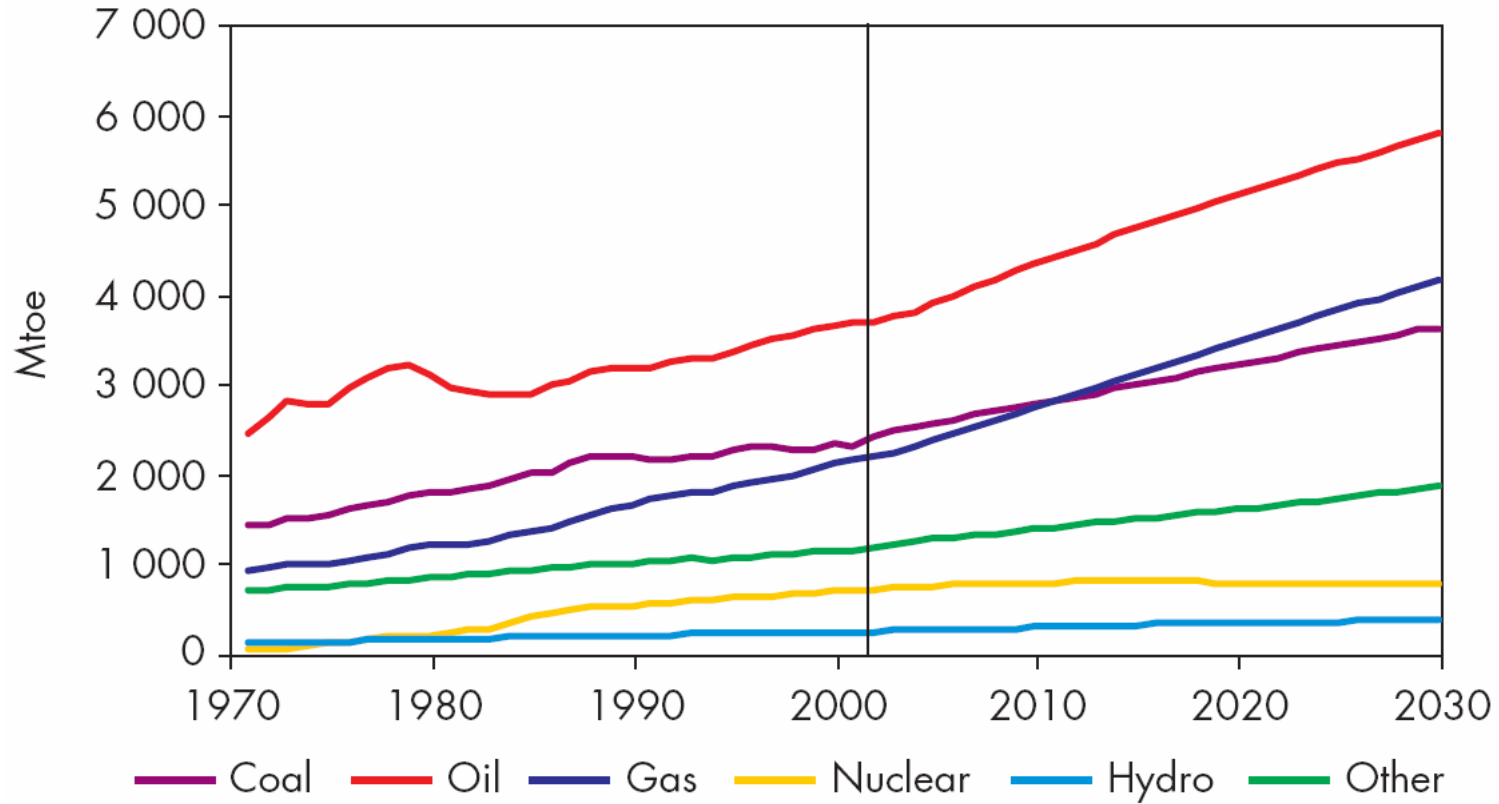


	<i>China</i>	<i>USA</i>	<i>World</i>
Population, millions	1280 ⁽¹⁾	288 ⁽³⁾	6230
GDP, trillion 2002\$ (ppp)	5.4 ⁽²⁾	10.4 ⁽¹⁾	32.3
Total energy use, EJ	44 ⁽²⁾	104 ⁽¹⁾	433
Recov'ble Coal Reserves, Bt	130 ⁽³⁾	270 ⁽¹⁾	1090
Coal consumption, EJ	29 ⁽¹⁾	23 ⁽²⁾	102
Electricity generation, TWh	1650 ⁽²⁾	4050 ⁽¹⁾	16180
Electricity from coal, TWh	1200 ⁽²⁾	2000 ⁽¹⁾	6270
C emitted in CO ₂ , MtC	910 ⁽²⁾	1570 ⁽¹⁾	6690
C emit in CO ₂ from coal, MtC	687 ⁽¹⁾	563 ⁽²⁾	2449

Sources: John Holdren, US-India Energy R&D Workshop, New Delhi, August, 2004,
DOE Energy Information Administration, International Energy Outlook 2002,
BP Statistical Review, International Energy Agency



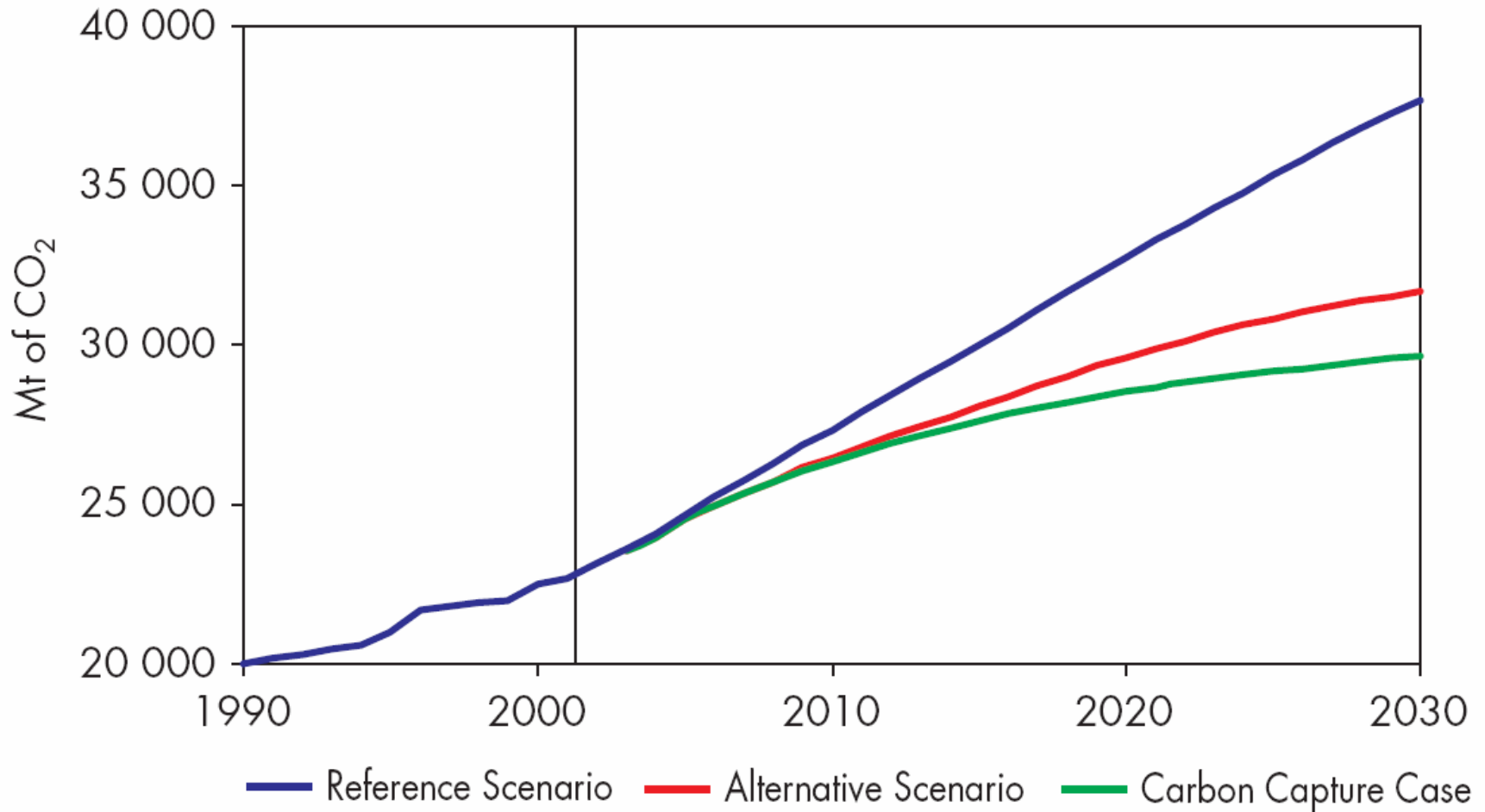
World Primary Energy Demand by Fuel



Source: IEA - World Energy Outlook 2004



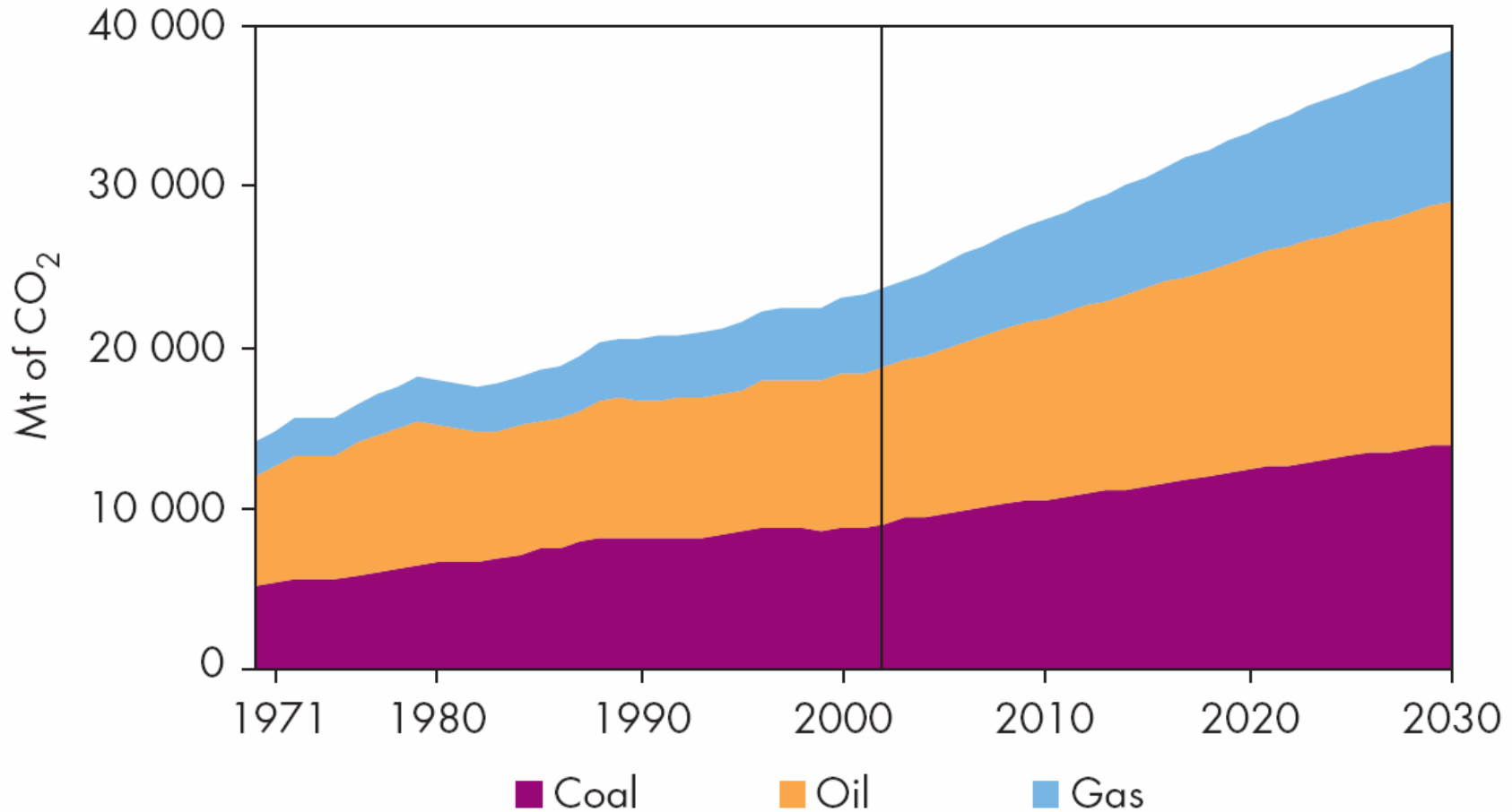
Projected Global Energy-Related CO₂ Emissions



Source: IEA - World Energy Outlook 2004



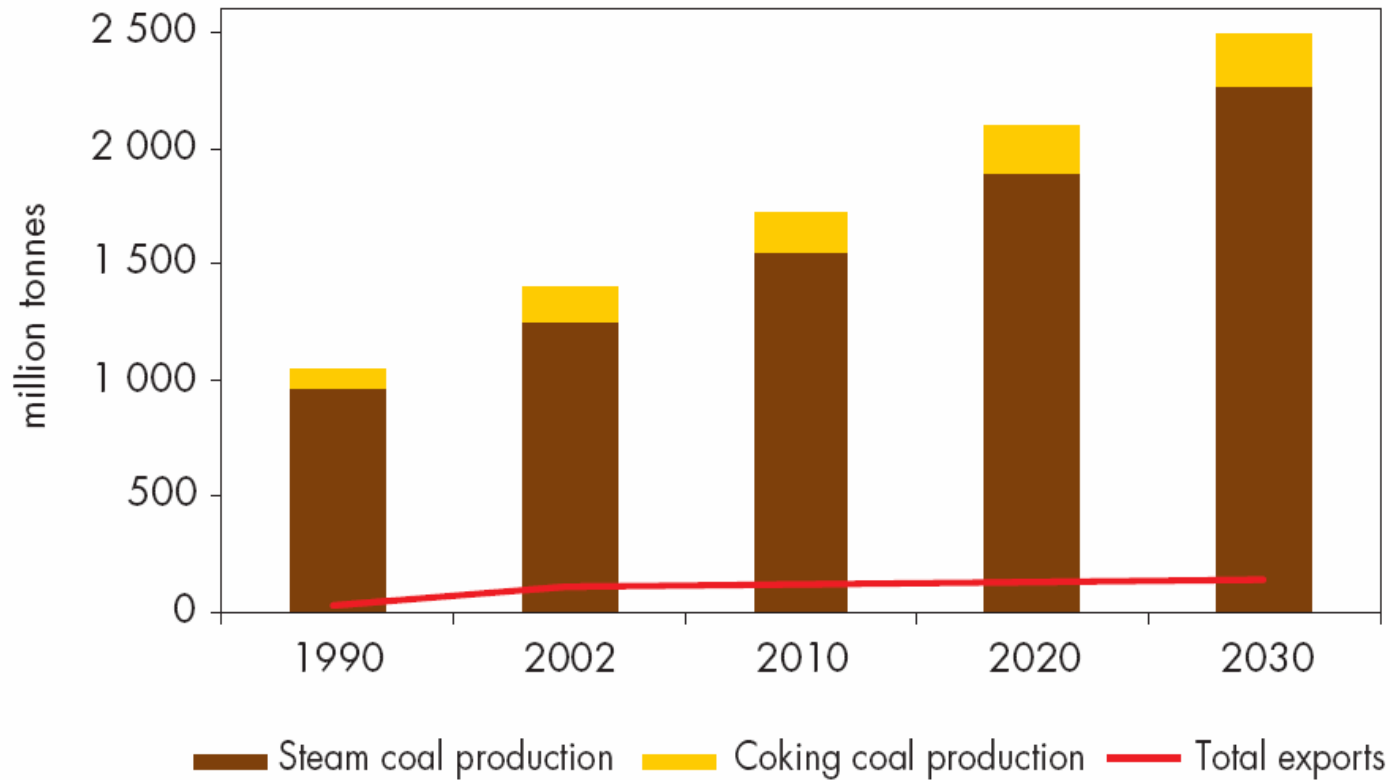
Projected Global Energy-Related CO₂ Emissions by Fuel



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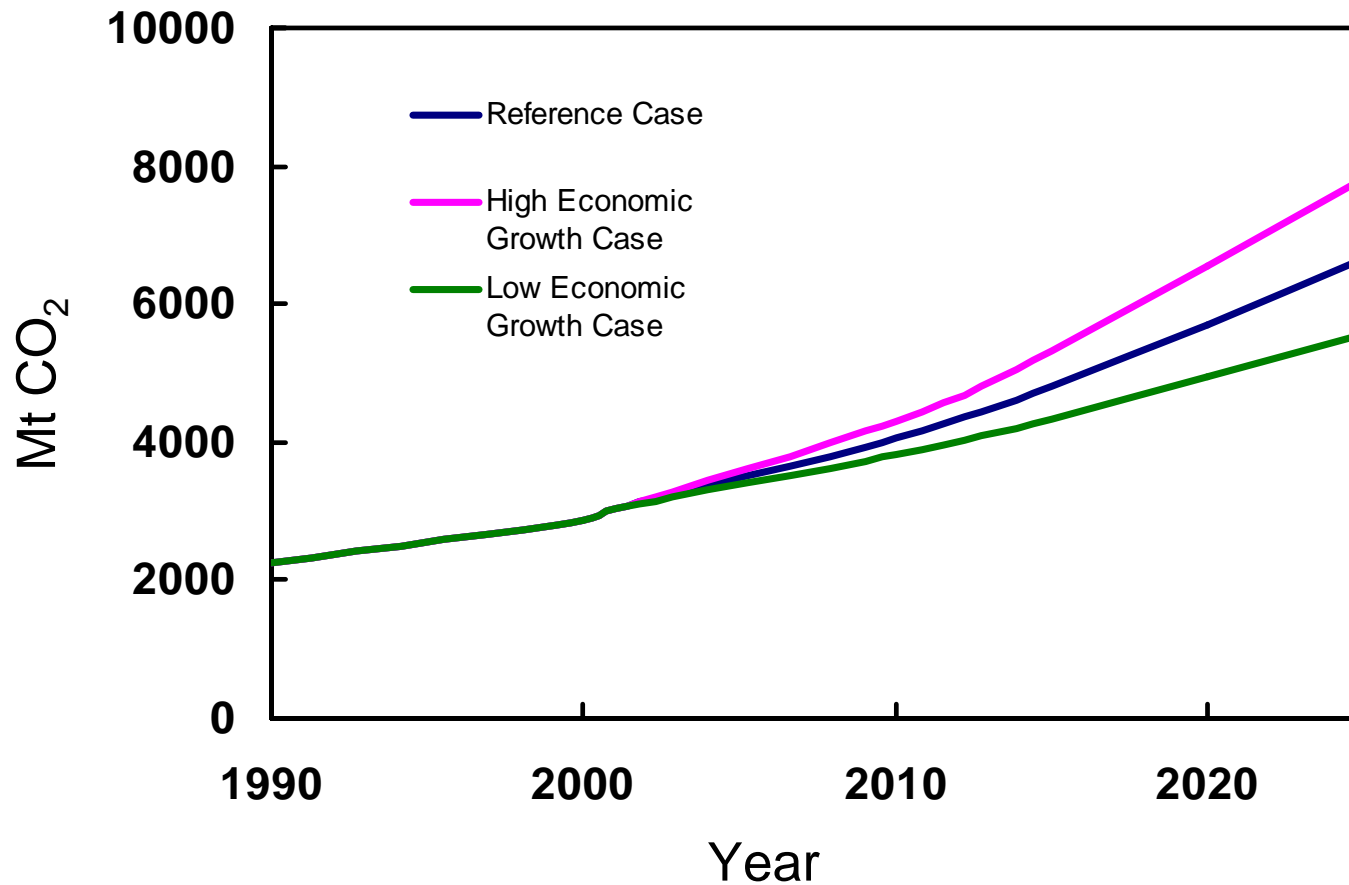
Projected Coal Production in China



Source: IEA - World Energy Outlook 2004



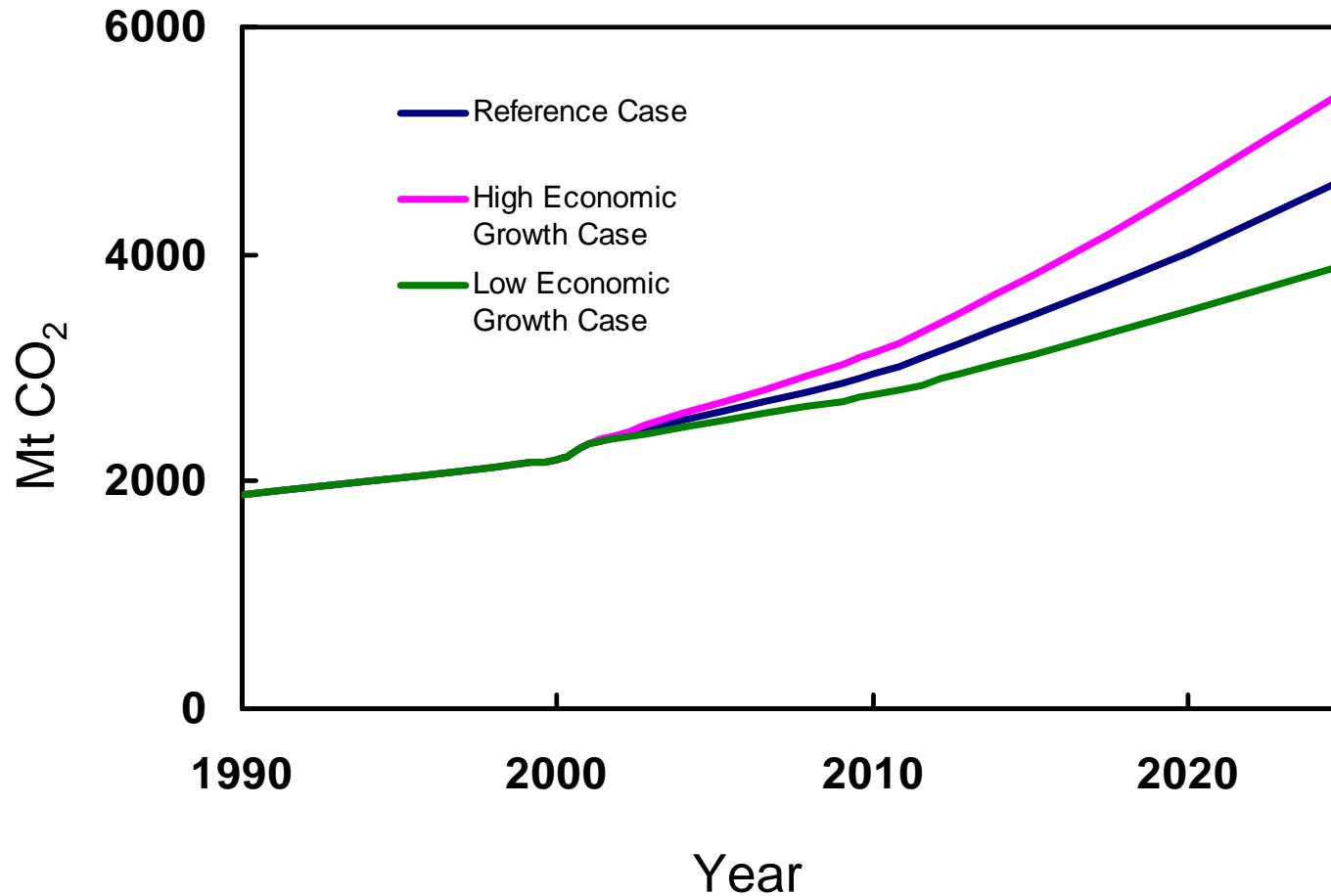
Projected China CO₂ Emissions Growth



Source: Data from EIA - International Energy Outlook 2004



Projected China CO₂ Emissions Growth from Coal



Source: Data from EIA - International Energy Outlook 2004



Questions for Workshop

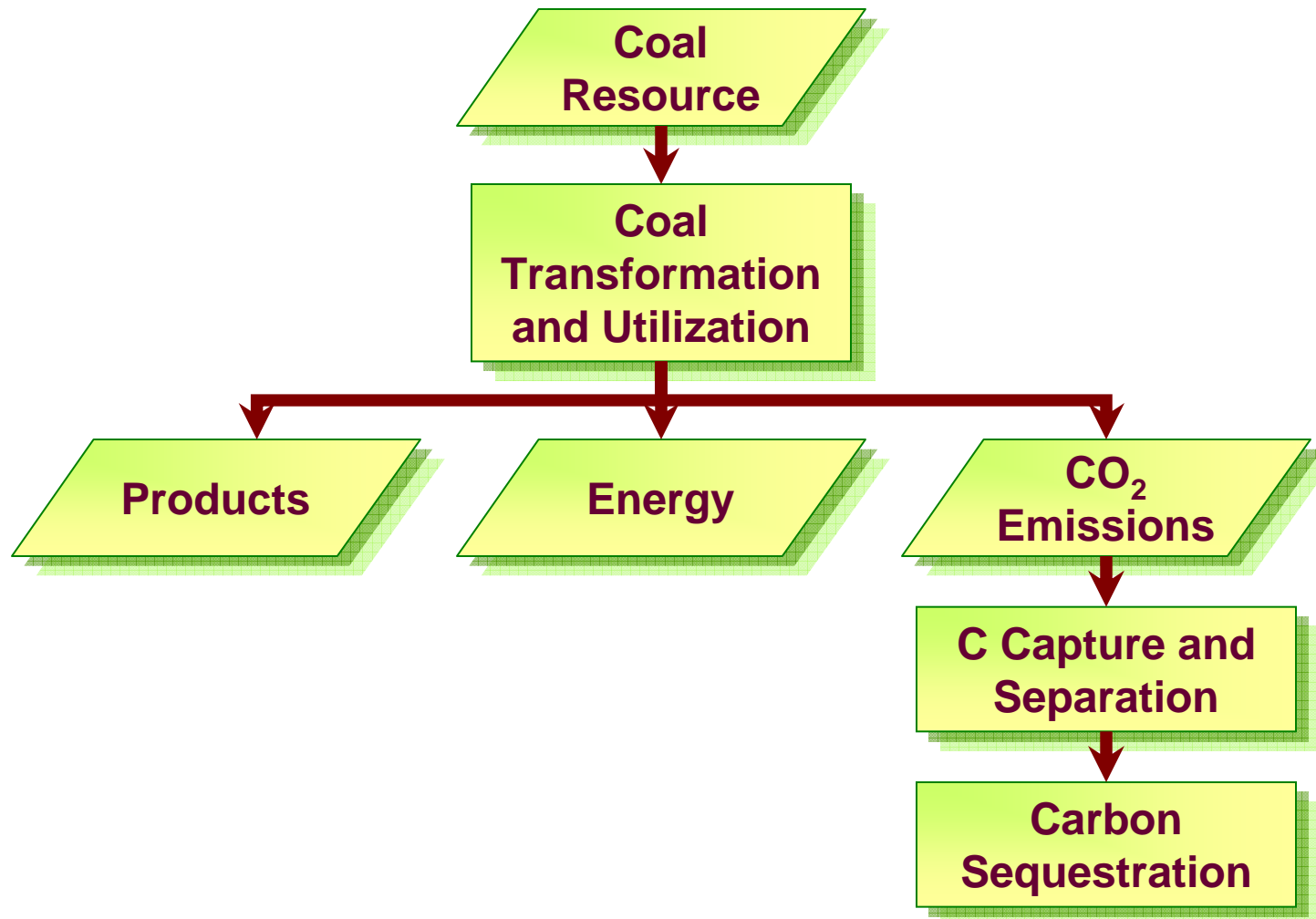


Exploring the Opportunities to Integrate Advanced Coal Technologies with Carbon Capture and Storage in China

- What are the technological barriers and challenges to developing coal-based energy systems with reduced greenhouse emissions and other environmental impacts?
- Which key technologies, if developed, could change the game for future coal use?
- Where do the research opportunities lie for integrating these technologies?
- How can these technology solutions be applied to address the unique environmental and energy needs of China?

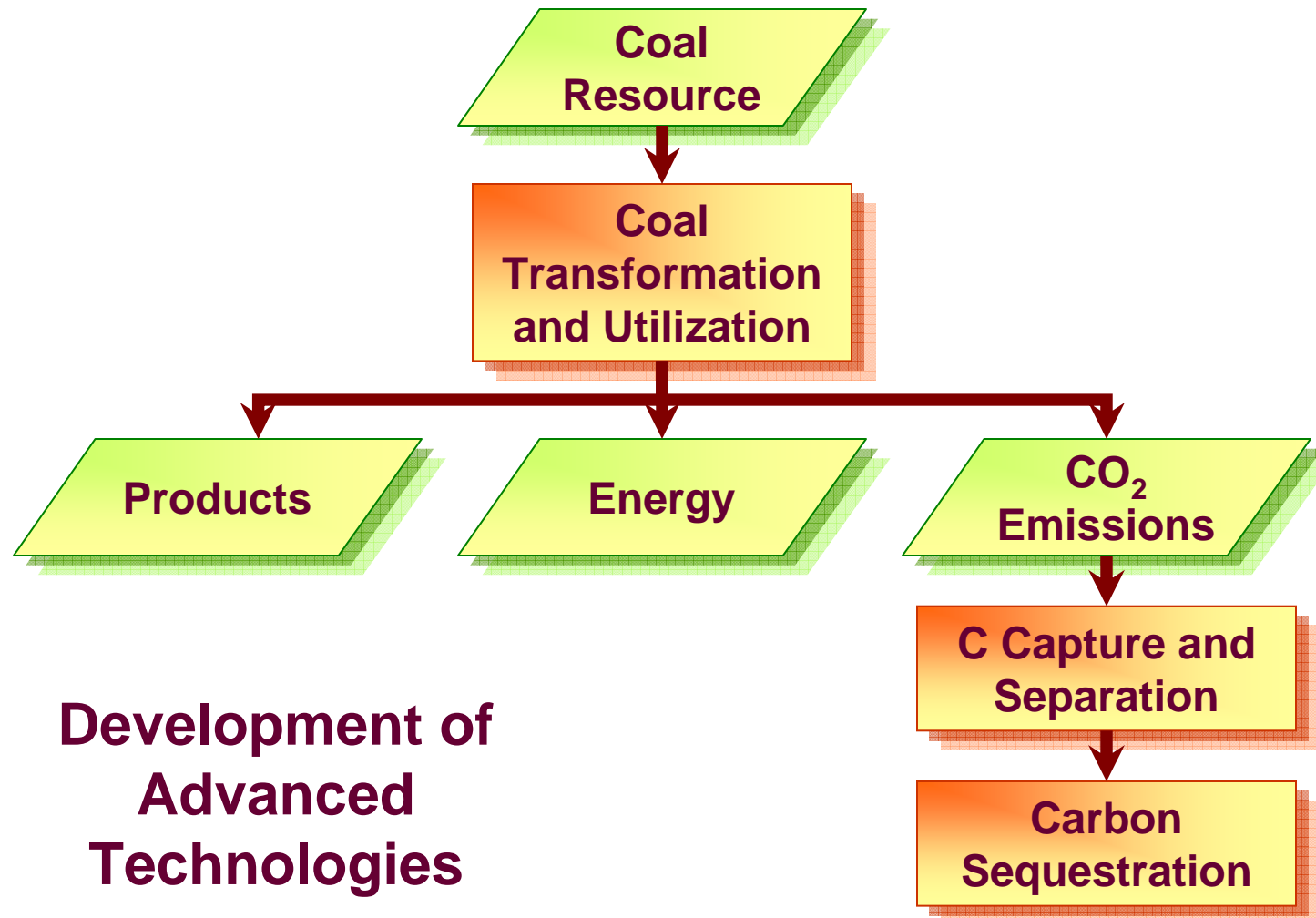


Coal Energy System



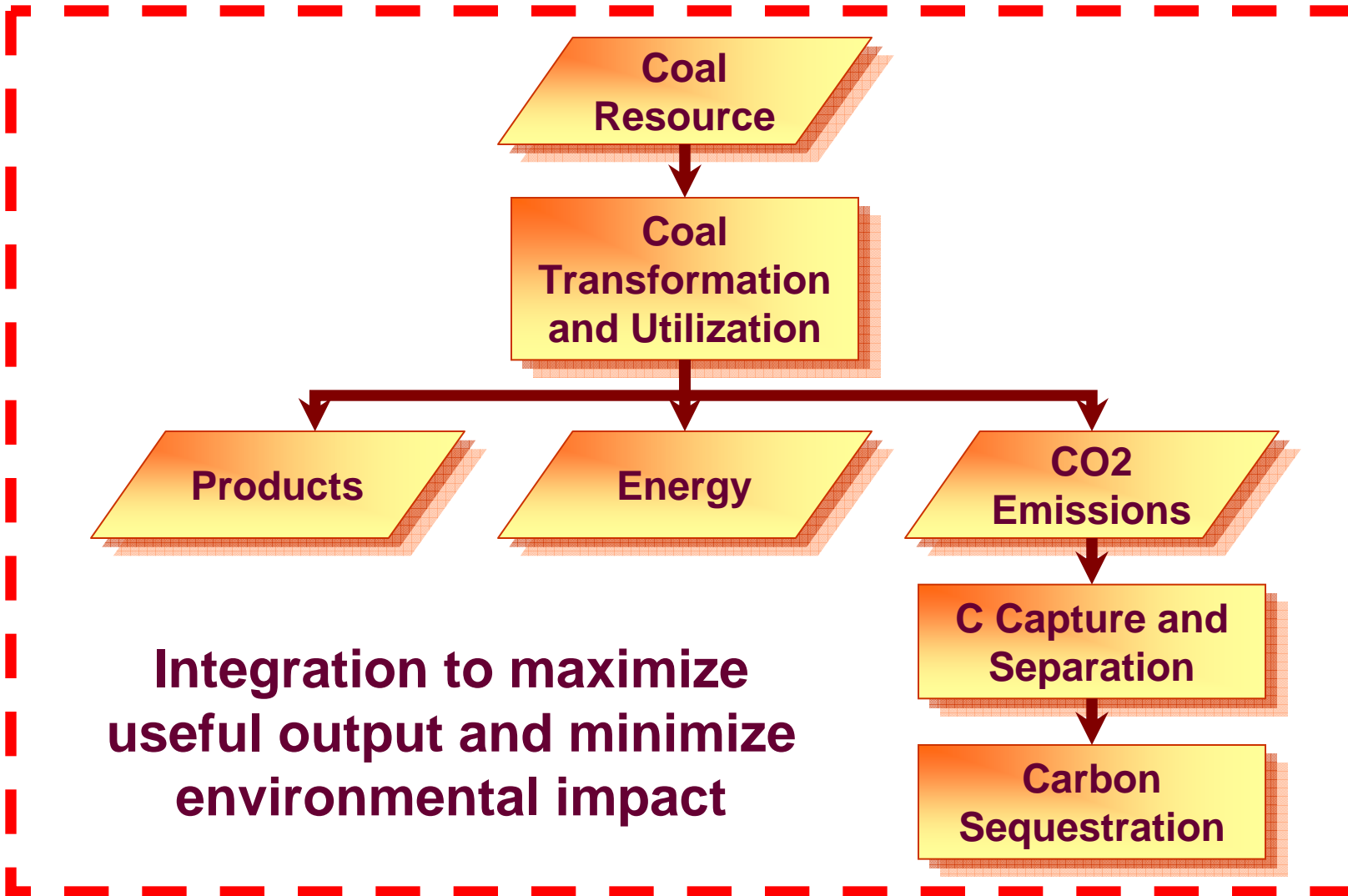


Coal Energy System



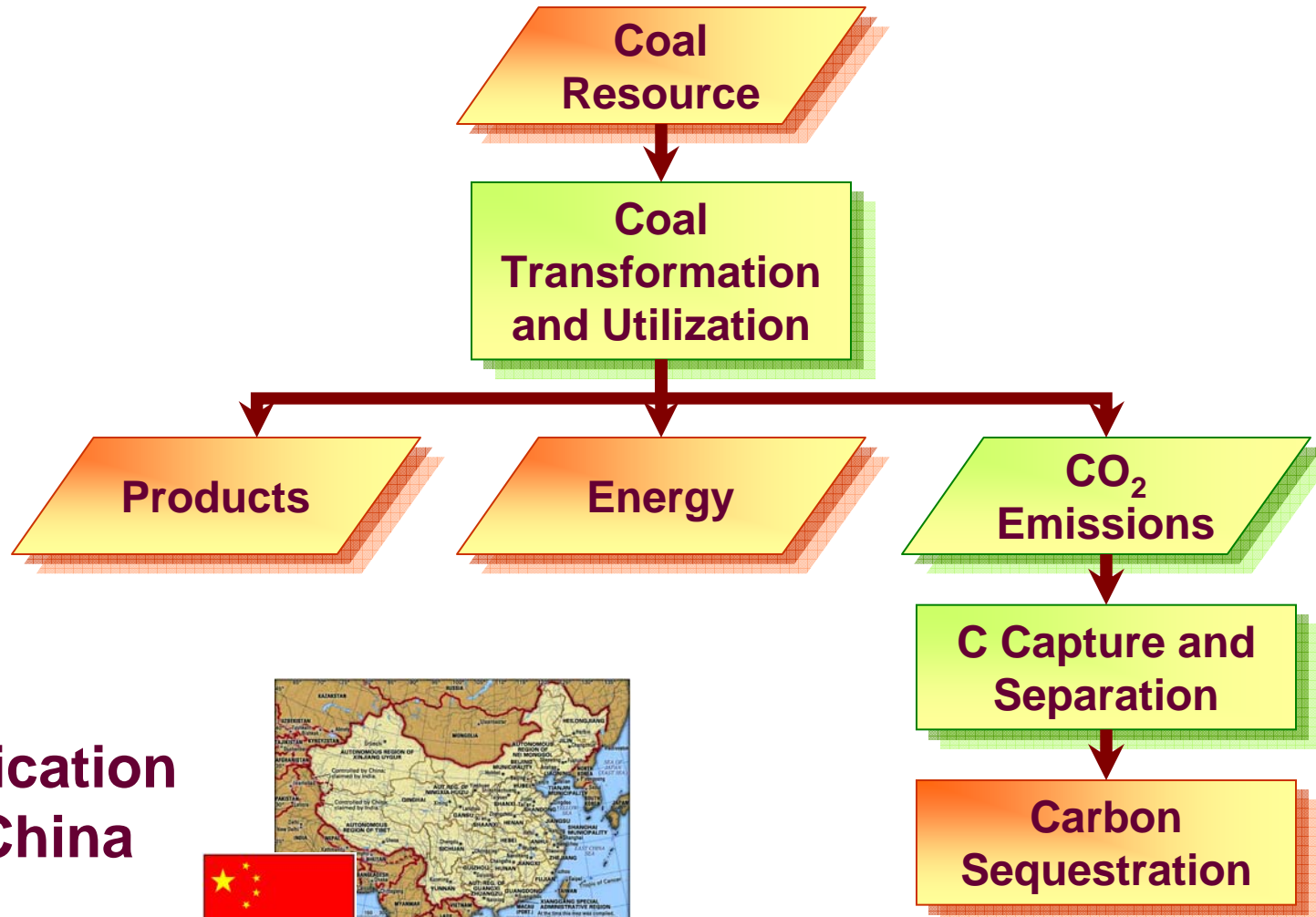


Coal Energy System





Coal Energy System



Application
in China





Workshop Sessions



- Introductory session on overall China coal research needs
- Six presentation sessions focused around:
 - Integration of technology solutions
 - Areas of research opportunity
 - Chinese and international perspectives
- Final discussion session:
 - Summary of key issues and themes identified at the workshop
 - Options to move forward to develop game-changing research



Thank You!



Prof. Ni Weidou, Cen Kefa, and Luo Zhongyang

- for selecting the topics and bringing this group together

Tsinghua University

- for hosting this meeting

Energy Foundation, Emilie Hung, Tsinghua and Zhejiang Universities

- for working hard to arrange this meeting

Our Sponsors

- for making this project possible

Our Speakers

- for sharing your time, expertise, and opinions with us

Attendees from China and around the world

- for taking time to participate